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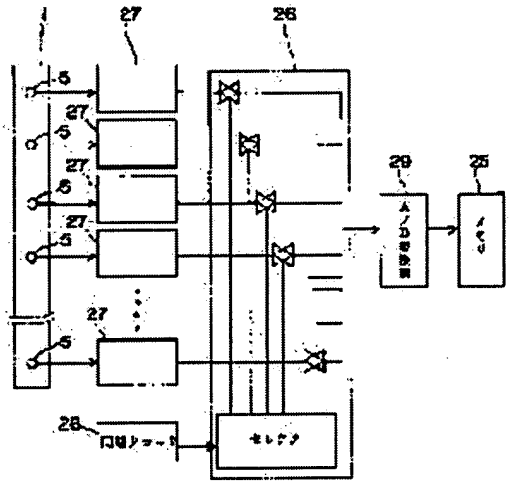
(54) SURFACE SHAPE DETECTION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an inexpensive non-contact detector of a simple structure capable of detecting projections or recessions on the surface of an object to be measured in a single relative motion by constituting a line sensor.

SOLUTION: Tips of many bar-shaped cores arranged in a line at a specified interval are mounted on the same plane and, at the same time, these tips are placed relatively movable opposite to a direction orthogonal to the above arranging detection on a measured object surface with projections and recessions in a magnetic field. A detection coil 5 for detecting changes in a magnetic flux generated by projections and recessions of the measured object is provided in each of the bar-shaped cores, an output of the detection coil 5 is A/D converted in a specified timing and stored in a memory 25, and the projections and recessions within a specified range is detected from data stored in the memory 25.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the surface type-like detection equipment which detects the concavo-convex configuration of the front face of a device under test by non-contact based on change of magnetic flux. Furthermore, when it explains in full detail, this invention relates to the surface type-like detection equipment which can detect the concavo-convex configuration of the front face of the device under test of the predetermined range only by carrying out relative displacement of the device under test once.
[0002]
[Description of the Prior Art] Conventionally, the concavo-convex configuration of the front face of a device under test can be measured to a precision, and, moreover, a dial gage is one of easy structure and cheap things. However, since this dial gage is what measures by fixing a device under test and contacting a probe to a concavo-convex side, that measurement will take long duration to it. For this reason, it is difficult for a short time to detect the concavo-convex configuration of the front face of a device under test, and the concavo-convex configuration of the front face of a device under test where it moves was not able to be applied to the application detected one after another, for example, the coin identification unit which included in the automatic vending machine.
[0003] With the coin identification unit built into the automatic vending machine, the data of various classes to a charge coin are collected by having two or more sensors, and distinction about the class and truth of a coin is performed there. There is an eddy current mold sensor as one of the sensors installed in a coin identification unit. This eddy current mold sensor is countered and installed in a coin path, and the flux reversal at the time of coin passage is detected electrically. Namely, since resistivity changes with the construction material and thickness of a coin, eddy current losses differ for every coin. Change of the magnetic flux by this eddy current loss is detected electrically, and an eddy current mold sensor outputs it. Therefore, coin distinction equipment judges the construction material of the coin thrown in based on change of the detection output of an eddy current mold sensor, thickness, a diameter, etc., also judges the data based on the detection output of the sensors of further others, and is performing the class of coin thrown in by contrasting with the data which have memorized these results beforehand, and distinction of truth. However, such coin distinction equipment has a complicated configuration, and is high cost.
[0004]
[Problem(s) to be Solved by the Invention] There is a request that he wants to distinguish the class and truth of a coin about the coin identification unit built into an automatic vending machine etc. on the other hand based on the complicated and fine concavo-convex configuration attached on the surface of the coin in the actual condition that alteration and forgery of a coin are growing into elaborateness more. Then, the concavo-convex configuration of the front face of a device under test can be detected by non-contact, and, moreover, development of surface type-like detection equipment easy [structure] and cheap is demanded in recent years.
[0005] Here, there are an approach of processing the image photographed with the CCD camera, a method of irradiating semiconductor laser in a concavo-convex side, and incorporating the reflected light with a photodiode etc., etc. as an approach of detecting a surface concavo-convex configuration by non-contact. However, the imitation coin in which the photograph of a real coin was stuck, for example since the concavo-convex configuration was processed as superficial image data by the approach of photographing an image with a CCD camera is undistinguishable, and the reflected light is difficult to get in the core having become depressed in irradiating light at an include angle shallow from the circumference, in order to make concavo-convex information easy to acquire optically, it becomes shade, and there is a possibility of taking this hollow for a hole. Moreover, it is necessary to make a laser beam scan in the shape of a field by the approach of incorporating the reflected light of semiconductor laser with a photodiode etc.

Furthermore, since the expensive equipments only for concavo-convex configurations will be separately installed by both approach of these in order rust, dirt, etc. of a concavo-convex side are of infinite variety, and to become the failure of discernment and to detect the concavo-convex configuration on the front face of a coin, it causes the increment in a manufacturing cost, and enlargement of equipment and is not appropriate. Therefore, it is expedient, if the existing sensor which detects the construction material which it had from the former in a coin identification unit can be developed, detection of the concavo-convex configuration on the front face of a coin can be enabled and the data about the concavo-convex configuration on the front face of a coin can be obtained together with data, such as construction material of a coin.

[0006] And development of this surface type-like detection equipment is demanded not only for the application of coin discernment but for other applications.

[0007] This invention can detect the concavo-convex configuration of the front face of a device under test by non-contact, and aims at offering the surface type-like detection equipment which can moreover be cheaply manufactured with easy structure.

[0008]

[Means for Solving the Problem] In order to attain this object surface type-like detection equipment according to claim 1 While arranging the head of the cylindrical core of arranged a large number on the same flat surface, the head of many cylindrical cores is made to counter the device-under-test front face which has irregularity in a field possible [the array direction] for relative displacement in the direction which intersects perpendicularly. spacing predetermined to a single tier -- alienation -- The detection means for detecting the flux reversal originated and generated in the concavo-convex configuration of a device under test at each of a cylindrical core is established. The concavo-convex configuration of the predetermined range is detected from the data which carried out A/D conversion of the output of this detection means to predetermined timing, stored in memory, and were stored in this memory.

[0009] Therefore, a detection means constitutes the line sensor put in order by the single tier in the direction which intersects perpendicularly to the direction of relative displacement with a device under test. Since the output of each detection means changes according to the concavo-convex configuration of the front face of a device under test where the head of a cylindrical core counters, the concavo-convex configuration of a device under test is once detectable on the whole surface target by relative displacement sampling the output of each detection means one after another to predetermined timing, carrying out relative displacement of the device under test to a line sensor. Although the output of each detection means is an analog signal, memory of it is changed and carried out to the digital signal suitable for signal processing by carrying out A/D conversion.

[0010] Moreover, surface type-like detection equipment according to claim 2 is made smaller than the width of face of the concavo-convex configuration which is going to detect the width of face about the direction of relative displacement at the head of many cylindrical cores, and is used as the magneto-resistive effect component attached in the sensing coil or cylindrical core around which the detection means was wound by the cylindrical core. Since a detection means detects change of the magnetic flux which influences a cylindrical core, the resolution as a sensor is determined by the thinness at the head of a cylindrical core. That is, making it smaller than the width of face of the concavo-convex configuration which is going to detect the width of face about the direction of relative displacement at the head of a cylindrical core detects the concavo-convex configuration of a device under test with resolution finer than this concavo-convex configuration. Moreover, change of the magnetic flux resulting from the concavo-convex configuration on the front face of a device under test is electrically detected by using a sensing coil or a magneto-resistive effect component as each detection means.

[0011] moreover, surface type-like detection equipment according to claim 3 -- a single tier -- alienation -- the cylindrical core of arranged a large number is put in order in the direction of two or more set relative displacement, and it arranges so that the cylindrical core of a backside train may be located between the cylindrical cores of a before side train about the direction of relative displacement. Therefore, the locus of the cylindrical core the increase of the group of the cylindrical core arranged to the single tier or at the time of carrying out relative displacement of the device under test, even if it carries out does not lap, but where [dense] spacing of the locus concerned is narrowed, it can detect the shape of surface type of a device under test. Moreover, in order to prevent magnetic interference of adjacent detection means, even if it sets up spacing of the cylindrical core in the same group widely, the shape of surface type of a device under test is detectable in the condition dense as a whole increasing the number of the groups of a cylindrical core.

[0012] Moreover, surface type-like detection equipment according to claim 4 forms the auxiliary core for flux path formation of the same width of face in the both sides whose cylindrical cores were pinched in between about the direction of relative displacement with a cylindrical core several one [same] as a cylindrical core. Therefore, an auxiliary core will be formed apart from the cylindrical core in which the detection means is formed, and an exiting

coil can be independently arranged from detection means by winding around this auxiliary core the exiting coil made to generate the field which a device under test passes.

[0013] In this case, like surface type-like detection equipment according to claim 5, while a cylindrical core and an auxiliary core are really formed from one magnetic material block, a device under test may consist of a metal or magnetic material.

[0014] Moreover, the exiting coil is wound around the cylindrical core or the auxiliary core, and surface type-like detection equipment according to claim 6 impresses a RF signal to an exiting coil. Therefore, the magnetic flux which pierces through a device under test changes the short-time period corresponding to a RF signal, and detection of a fine concavo-convex configuration is attained.

[0015] Furthermore, the device under test of surface type-like detection equipment according to claim 7 is a coin, and width of face about the direction of relative displacement at the head of a cylindrical core is set to 2mm or less. Since a detection means detects change of the magnetic flux which influences a cylindrical core, the resolution of a sensor is determined by the size at the head of a cylindrical core. Although the fine concavo-convex configuration is formed on the surface of the coin, the concavo-convex configuration on the front face of a coin is detectable with the resolution required of distinction of a coin by setting width of face about the direction of relative displacement at the head of a cylindrical core to 2mm or less.

[0016] While arranging the head of the cylindrical core of arranged a large number on the same flat surface, the head of many cylindrical cores is made to counter the device-under-test front face which has irregularity in a field. moreover, spacing predetermined in surface type-like detection equipment according to claim 8 to a single tier -- alienation -- The detection means for detecting the flux reversal originated and generated in the concavo-convex configuration of a device under test at each of a cylindrical core is established, and the concavo-convex configuration of the predetermined range of a device under test is detected from the output of this detection means. Therefore, a detection means constitutes the line sensor used making counter a device under test. Since the output of each detection means changes according to the concavo-convex configuration of the front face of a device under test where the head of a cylindrical core counters, the concavo-convex configuration of a location where each detection means of the front face of a device under test counters is detectable.

[0017] Moreover, surface type-like detection equipment according to claim 9 is made smaller than the crevice or heights width of face of a concavo-convex configuration which is going to detect the width of face at the head of many cylindrical cores, and is used as the magneto-resistive effect component attached in the sensing coil or cylindrical core around which the detection means was wound by the cylindrical core. Since a detection means detects change of the magnetic flux which influences a cylindrical core, the resolution as a sensor is determined by the thinness at the head of a cylindrical core. That is, making it smaller than the crevice or heights width of face of a concavo-convex configuration which is going to detect the width of face at the head of a cylindrical core detects the concavo-convex configuration of a device under test with resolution finer than this concavo-convex configuration. Moreover, change of the magnetic flux resulting from the concavo-convex configuration on the front face of a device under test is electrically detected by using a sensing coil or a magneto-resistive effect component as each detection means.

[0018] moreover, surface type-like detection equipment according to claim 10 -- a single tier -- alienation -- the concavo-convex configuration of the predetermined range of the direction which put two or more sets of cylindrical cores of arranged a large number in order, and was compared with the direction of a single tier two or more sets with the detection means is detected. Therefore, a detection means will be arranged two-dimensional in all directions, and the concavo-convex configuration of the predetermined range of a device under test can be detected at once, without carrying out relative displacement of the head of a cylindrical core to a device under test.

[0019] moreover, surface type-like detection equipment according to claim 11 -- a single tier -- alienation -- the predetermined range formed by putting two or more sets of cylindrical cores of arranged a large number in order is set as the larger range than the magnitude of a device under test. Therefore, the concavo-convex configuration of the whole front face of a device under test can be detected at once, without carrying out relative displacement of the head of a cylindrical core to a device under test.

[0020] Moreover, surface type-like detection equipment according to claim 12 forms the auxiliary core for flux path formation of the same width of face in the both sides whose cylindrical cores were pinched in between with a cylindrical core several one [same] as a cylindrical core. Therefore, an auxiliary core will be formed apart from the cylindrical core in which the detection means is formed, and an exiting coil can be independently arranged from a detection means by winding around this auxiliary core the exiting coil made to generate the field which a device under test passes.

[0021] Furthermore, the exiting coil is wound around the cylindrical core or the auxiliary core, and surface type-like

detection equipment according to claim 1 impresses a RF signal to an exiting coil. Therefore, the field which pierces through a device under test changes the short-time period corresponding to a RF signal, and detection of a fine concavo-convex configuration is attained.

[0022]

[Embodiment of the Invention] Hereafter, it explains to a detail based on the best gestalt which shows the configuration of this invention to a drawing.

[0023] An example of the operation gestalt of the surface type-like detection equipment which applied this invention to drawing 3 from drawing 1 is shown. This surface type-like detection equipment While arranging the head of the cylindrical core 3 of arranged a large number on the same flat surface, the head of many cylindrical cores 3 is made to counter the front face of the device under test 10 which has irregularity in a field possible [the array direction at the head of the above-mentioned cylindrical core 3] for relative displacement in the direction which intersects perpendicularly. spacing predetermined to a single tier -- alienation -- The detection means 5 for detecting the flux reversal originated and generated in the concavo-convex configuration of a device under test 10 at each of the cylindrical core 3 is established. The concavo-convex configuration in the predetermined range of a device under test 10 is detected from the data which carried out A/D conversion of the output of the detection means 5 to predetermined timing, stored in memory 25, and were stored in this memory 25.

[0024] Here, while having irregularity, when being displaced relatively in the direction in which the array direction at the head of the above-mentioned cylindrical core 3 and the device under test 10 which consists of a metal or magnetic material cross at right angles, actuation of an about is explained using one cylindrical core 3.

[0025] Now, die-length [of two sides] w which meets in the direction of relative displacement concerned among the neighborhoods of apical surface 3a of the width of face w 3 about the migration direction concerned of apical surface 3a of each cylindrical core 3, i.e., a cylindrical core, supposing the direction of relative displacement of a device under test 10 is the drawing 4 Nakaya mark direction, as shown in drawing 4 is set up smaller than the width of face of the concavo-convex configuration which it is going to detect. For example, when a device under test 10 is a coin, die-length w which meets in the direction of relative displacement concerned of apical surface 3a of the above-mentioned cylindrical core 3 is set to the value smaller than the width of face of the crevice of a concavo-convex configuration or heights which is going to detect the front face of a coin 10, for example, the value of 2mm or less. In addition, what is necessary is for a value smaller than the width of face of the crevice of the concavo-convex configuration which it is going to detect, or heights not to necessarily mean that it is smaller than the width of face of the minimum crevice or heights, and just to determine that the resolution needed based on the width of face which it is going to detect is obtained. It will become what is inferior as compared with the case where resolution is 2mm or less as data which the resolution of detection will become [as opposed to / generally / the irregularity configuration of the front face of a coin 10] coarse if the above-mentioned width of face w becomes large 2mm when a device under test 10 is a coin, detection of a fine irregularity configuration becomes difficult, and are used for distinction [truth / of a coin 10]. However, it is important to set up width of face w according to the width of face of the concavo-convex configuration of the device under test 10 which does not have to set width of face w to 2mm or less, and is not necessarily going to detect it, and required resolution.

[0026] Moreover, when what is necessary is just to detect a concavo-convex configuration roughly, it is not necessary to set up the above-mentioned width of face w smaller than the width of face of a concavo-convex configuration, and it will be satisfactory, if the resolution required of detection is satisfied even if large the dimension near the width of face of a concavo-convex configuration, and a little.

[0027] Although the irregularity of various width of face is intermingled in many cases in the concavo-convex configuration in a device under test 10 which it is going to detect, it is good to set up the width of face w of the cylindrical core 3 generally on the basis of the minimum width of face of a concavo-convex configuration. For example, since the minimum width of face of the concavo-convex configuration which excepted the fine alphabetic character and which should be detected is a part for the heights of a rim as shown in (B) when detecting the concavo-convex configuration of a 1 yen coin (construction material: aluminum) shown in drawing 13 (A), width of face w is set up on the basis of a part for the heights of this rim. If it is based on this minimum width of face and the twist also sets width of face w as the small value, detection of all concavo-convex configurations will be attained. By doing in this way, even if the relative-displacement locus of the cylindrical core 3 is P line of drawing 13 (A) and it is Q line, a concavo-convex configuration is detectable good. However, what is necessary is just to make width of face w of the cylindrical core 3 smaller than the smallest width of face among the width of face of the concavo-convex configuration of a pattern [that it is an object for detection] part, when what is necessary is just to detect the concavo-convex configuration of an encaustic part, without being based on a part for the heights of a rim, and necessarily not setting

width of face w as a value with a small twist, for example, performing configuration detection for heights of a rim. For example, what is necessary is just to make width of face w of the cylindrical core 3 into the small value from the width of face W1 and W2 of the concavo-convex configuration which it is going to detect, for example, the width of face of heights, in the case of drawing 13 (B). Namely, what is necessary is to decide whether want to detect and just to make it become smaller than the width of face to the width of face of which magnitude among concavo-convex configurations to detect. In this case, while it is vividly detectable about the irregularity of the width of face of magnitude to detect, grasp of an outline configuration is possible also about the irregularity of small width of face without the need of detecting.

[0028] The detection means 5 is the sensing coil wound around the cylindrical core 3. Moreover, the auxiliary core 7 for flux path formation of the same width of face as the cylindrical core 3 is formed in the both sides whose cylindrical cores 3 were pinched in between about the above-mentioned relative-displacement direction several one [same] as the cylindrical core 3, and the exiting coil 6 is wound around the auxiliary core 7 of these both sides. In addition, it is not necessary to necessarily form the auxiliary core 7 in the both sides of the cylindrical coil 3, and you may make it form the auxiliary core 7 only in either. Moreover, what is necessary is to omit formation of the auxiliary core 7 of both sides, and just to wind an exiting coil 6 around the cylindrical core 3 in this case.

[0029] The RF signal 14 is impressed to each exiting coil 6 as an excitation signal, and the space where a device under test 10 is displaced relatively is made to generate a field, as shown in drawing 5 . Passage of the inside of this field of the device under test 10 which has the metal section etc. changes magnetic flux. Since change of this magnetic flux changes the degree of that change according to the construction material of spacing of apical surface 3a of the cylindrical core 3, and a device under test 10, or the metal of a device under test 10, the output of a sensing coil 5 changes according to the surface concavo-convex configuration and the construction material of a device under test 10. After the output of each sensing coil 5 is amplified by the amplifier circuit 11 of the detection signal circuit 27, half-wave rectification of it is carried out by a detector circuit 12 and the peak hold circuit 13, and envelope detection is carried out, and it serves as a wave-like analog signal proportional to the concavo-convex configuration of a device under test 10. In addition, reverse is sufficient as the sequence of magnification and detection. And as shown in drawing 1 , the analog signal of all the sensing coils 5 is supplied to an analog multiplexer 26. An analog multiplexer 26 supplies the analog signal of each sensing coil 5 to A/D converter 29 in order to the predetermined timing based on the pulse from a synchronous clock 28. Sequential storing of the digital signal changed by A/D converter 29 is carried out at memory 25. In addition, since a device under test 10 decreases the magnetic flux in which the eddy current generated in the device under test 10 concerned influences the cylindrical core 3 in the case of a metal etc., the output signal of a sensing coil 5 will change. Moreover, since the leakage of the magnetic flux from the device under test 10 concerned decreases [a device under test 10] in the case of the magnetic substance etc., the output signal of a sensing coil 5 will change. Therefore, with the surface type-like detection equipment of this invention, even if it is not only when a device under test 10 is a metal etc., but the magnetic substance etc., a surface concavo-convex configuration is detectable.

[0030] the direction in which each cores 3 and 7 and each coils 5 and 6 intersect perpendicularly to the direction of relative displacement with this surface type-like detection equipment -- a single tier -- alienation -- it is arranged and the line sensor 1 is constituted. And this line sensor 1 is arranged so that a device under test 10 may be displaced relatively in the inside of the field which each exiting coil 6 generates. For example, in using it as a sensor for coin discernment built into the coin identification unit of an automatic vending machine etc., it makes it a coin pass through the inside of the field which arranges a line sensor 1 near the coin path, and each exiting coil 6 generates.

[0031] If the sensing coil 5 prepared in the cylindrical core 3 which counters that center position is examined in case the coin 10 as a device under test is now displaced relatively, concerning the sensing coil 5 prepared in the cylindrical core 3 located in the center of a longitudinal direction of a line sensor 1, in connection with the relative displacement of a coin 10, the output signal shown in drawing 6 will be acquired from the detection signal circuit 27 corresponding to this sensing coil 5. This output signal becomes low corresponding to the heights of a coin 10, and becomes high corresponding to a crevice. And the same output will be obtained, if an output becomes high and there is a hole on the way further rather than the case where the crevice is supported until a coin 10 counters the cylindrical core 3. That is, although the wave of this output signal corresponds to the concavo-convex configuration of the front face of a coin 10, the information 24 grade about the information 21 about the difference of the height of the edge of a coin 10 and a center section, the information 22 about the width of face of a edge, the information 23 about a diameter, construction material, or thickness can be obtained simultaneously. Therefore, when it is used as a sensor for coin discernment, in addition to the information about a surface concavo-convex configuration, such information 21-24 can be detected simultaneously.

[0032] Thus, from each of the detection signal circuit 27 connected to the sensing coil 5 which constitutes a line sensor 1, the wave-like analog signal proportional to the concavo-convex configuration of the front face of the coin 10 in alignment with the relative-displacement locus of the corresponding cylindrical core 3 is outputted, respectively. A/D conversion of the output signal of each detection signal circuit 27 is carried out to sequence to predetermined timing by the analog multiplexer 26 and A/D converter 29, and it is memorized by memory 25. That is, as a round mark shows, once it carries out relative displacement of a coin 10 and the line sensor 1 to drawing 7 , the data about the concavo-convex configuration of the front face of a coin 10 are sampled in the shape of a mesh, and, on the whole, the front face of a coin 10 can be detected. That is, the concavo-convex configuration of the range where a line sensor 1 is displaced relatively is detected. In addition, as for using a line sensor 1 as a sensor for coin discernment, it is needless to say that it is not what is an example and is restricted to the application of coin discernment.

[0033] As mentioned above, although the data about the concavo-convex configuration of the front face of a coin 10 are sampled in the shape of a mesh and the front face of a coin 10 can be detected on the whole by the relative displacement of the once of a coin 10 and a line sensor 1 as a round mark shows to drawing 7 if the output of a line sensor 1 is used In a momentary point in case the center section of the coin 10 passes a line sensor 1 if needed Or migration of a coin 10 is made to suspend at this time, and even if it detects the detecting signal from each sensing coil 5 which constitutes the line sensor 1 at this time, the detection result about the concavo-convex configuration of the lengthwise direction in the center section of the coin 10 can be obtained. The detection result about the concavo-convex configuration at this time can detect the concavo-convex configuration of the lengthwise direction passing through the core of a coin in drawing 13 (A).

[0034] Moreover, so that the whole field which is going to detect many line sensors 1 in a longitudinal direction may be included Or when it arranges in the contiguity condition and the predetermined location or the whole of a coin 10 enters in the field so that a larger field than a coin 10 may be formed Migration of a coin is stopped, and if the detecting signal from each sensing coil 5 which constitutes each line sensor 1 is detected, on the whole, the front face of a coin 10 is detectable also by the idle state. If it can shift one location at a time and the line sensor arranged in a longitudinal direction is put in order at this time as shown in drawing 10 , the whole concavo-convex configuration can be detected in homogeneity.

[0035] That is, even if it does not move the cylindrical core 3 relatively to a device under test 10 by arranging the above-mentioned cylindrical core 3 two-dimensional in all directions, the shape of surface type of a device under test 10 can be detected at once.

[0036] The surface type-like detection equipment of this operation gestalt constitutes the line sensor 1 from really forming many the cylindrical cores 3 and the auxiliary cores 7 from the ferrite block 18 of a rectangular parallelepiped configuration. That is, it changes into the condition which slot 18a and step 18b in alignment with a longitudinal direction are machined to the ferrite block 18 first shown in (a), and shows in (b) as [show / in drawing 8]. Next, the core object 2 with which each cylindrical core 3 and each auxiliary core 7 were really formed as predetermined number machining of the slot 18c was carried out at suitable spacing for this ferrite block 18 and it was shown in (c) is manufactured. Thus, if many the cylindrical cores 3 and the auxiliary cores 7 are really formed by machining, since a base side can be constituted from a condition of having connected as one block, many the cylindrical cores 3 and the auxiliary cores 7 can be arranged to accuracy at intervals of predetermined.

[0037] However, it is not necessary to necessarily form each cylindrical core 3 and the auxiliary core 7 really from one ferrite block 18, two or more things in which only the predetermined number formed the cylindrical core 3 and the auxiliary core 7 may be joined to the ferrite block 18 shorter than the ferrite block shown in drawing 8 (a), and the line sensor 1 of predetermined length may be constituted. Or as shown in drawing 9 , it may unify by putting in order much core objects 2 with which one cylindrical core 3 and two auxiliary cores 7 were formed, for example, joining to the ceramic plate 30, and a line sensor 1 may be constituted.

[0038] In addition, although each above-mentioned gestalt is the example of the suitable gestalt of this invention, in the range which is not limited to these and does not deviate from the summary of this invention, deformation implementation is variously possible for it. For example, although above-mentioned explanation explained the coin as a device under test, this invention can detect the concavo-convex configuration of the front face of various things where construction material consists of a metal, the magnetic substance, etc.

[0039] Moreover, although cylindrical core 3 grade is arranged in a single tier and the line sensor 1 is constituted, the double sequence-of-numbers ****** line sensor 1 may be constituted for the cylindrical core 3. namely, a single tier -- alienation -- the cylindrical core 3 of arranged a large number may be put in order in the direction of relative displacement of two or more set device under test 10, and you may arrange so that the cylindrical core 3 of a backside train may be located between the cylindrical cores 3 of a before side train about this direction of relative displacement.

drawing 10 -- a single tier -- alienation -- cylindrical core 3 of arranged a large number is put in order in the direction of relative displacement of the 2-set device under test 10, and signs that it has arranged so that the cylindrical core 3 of eye two trains may be located between the cylindrical cores 3 of eye one train are shown. Since the cylindrical core 3 of eye one train and the cylindrical core 3 of eye two trains are arranged by turns, the relative-displacement locus of the cylindrical core 3 of each train cannot lap, but can increase the number of the cylindrical cores 3, and can detect the shape of surface type of a device under test 10 in the dense condition. For example, even if it is the case where spacing of the cylindrical core 3 must be made large in order to prevent magnetic interference of the adjacent sensing coil 5 when spacing of the cylindrical core 3 of a single tier cannot not much be narrowed from the constraint on structure and processing etc., the relative-displacement locus of the cylindrical core 3 can be changed into a dense condition by increasing the train of the cylindrical core 3, and a device under test 10 can be detected.

[0040] Moreover, although the detection means considered as the sensing coil 5 wound around the cylindrical core 3 in above-mentioned explanation, the magneto-resistive effect component for detecting change of the magnetic flux which replaced with the sensing coil 5 and originated in the concavo-convex configuration may be attached in the cylindrical core 3.

[0041] Moreover, although it had two coils 5, i.e., a sensing coil, and an exiting coil 6 in above-mentioned explanation, it is not necessary to necessarily have two coils 5 and 6, and these may be made into one coil and may be constituted. In this case, what is necessary is to carry out circuitry so that the inductance change in the coil concerned can be detected at the same time it excites with one coil, and just to make it detect change of magnetic flux based on this detection result.

[0042] Furthermore, what is necessary is not to necessarily restrict to a RF signal and just to use the signal according to a device under test 10, the resolution of the detection, etc. as a signal impressed to an exiting coil 6. However, when using it as a sensor for coin discernment, the activity of an AC signal with a frequency of 10MHz is desirable from 1kHz. It is because it becomes what is inferior to resolution as data for distinguishing a class, truth, etc. of a coin in less than 1kHz, and is because an impedance rises, actuation of a sensor will become difficult or the diving noise between the signal wiring which does not mind a magnetic circuit will become large, if 10MHz is exceeded.

[0043]

[Example] Next, in order to investigate the relation between the width of face w of apical surface 3a of the cylindrical core 3, and the resolution of concavo-convex configuration detection, the experiment which changes the value of width of face w and detects the shape of surface type of a coin (construction material: cupronickel) of 500 yen was conducted. When the width of face of irregularity to detect is about 1mm, the wave of the output signal of the sensing coil 5 at the time of setting width of face w to 3mm for the wave of the output signal of the sensing coil 5 at the time of setting width of face w to 0.5mm at drawing 11 at drawing 12 is shown. Although the wave of an output signal could become even on the whole and the information 21 (refer to drawing 6) about the difference of the height of the edge of a 500 yen coin and a center section, the information 23 about a diameter, and the information 24 grade about the thickness of construction material could be checked when width of face w was set to 3mm (drawing 12), detection of a surface concavo-convex configuration was difficult. On the other hand, when width of face w is set to 0.5mm (drawing 11), change of the configuration of an output signal follows change of the shape of surface type of a coin good 500 yen. It has checked that the description of a fine concavo-convex configuration was more detectable to fitness by making width of face w small by this. Moreover, it turned out [which obtain resolution sufficient by setting width of face w to 0.5mm to use it as a sensor for distinguishing a class, truth, etc. of a coin] that things can be carried out.

[0044]

[Effect of the Invention] As explained above, with surface type-like detection equipment according to claim 1 While arranging the head of the cylindrical core of arranged a large number on the same flat surface, the head of many cylindrical cores is made to counter the device-under-test front face which has irregularity in a field possible [the array direction] for relative displacement in the direction which intersects perpendicularly. spacing predetermined to a single tier -- alienation -- The detection means for detecting the flux reversal originated and generated in the concavo-convex configuration of a device under test at each of a cylindrical core is established. Since the concavo-convex configuration of the predetermined range is detected from the data which carried out A/D conversion of the output of this detection means to predetermined timing, stored in memory, and were stored in this memory, a detection means can constitute a line sensor and non-contact can detect the concavo-convex configuration of the whole front face of a device under test by one scan. Moreover, since a detection means is formed in the cylindrical core arranged in the single tier and he is trying to detect magnetic variation, the structure of a line sensor will become easy and a manufacturing cost can be held down.

[0045] Moreover, since it was made smaller than the width of face of the concavo-convex configuration which is going to detect the width of face about the direction of relative displacement at the head of many cylindrical cores, the concavo-convex configuration of a device under test is detectable with resolution finer than the concavo-convex configuration of a device under test with surface type-like detection equipment according to claim 2. Moreover, since it considered as the magneto-resistive effect component attached in the sensing coil or cylindrical core around which the detection means was wound by the cylindrical core, change of the magnetic flux resulting from the concavo-convex configuration on the front face of a device under test is electrically detectable.

[0046] moreover, with surface type-like detection equipment according to claim 3 a single tier -- alienation, since it has arranged so that the cylindrical core of arranged a large number may be put in order in the two or more set up diagnosis pair migration direction and the cylindrical core of a backside train may be located between the cylindrical cores of a before side train about the above-mentioned relative-displacement direction While becoming possible the increase of a number, and to carry out and to detect [of a cylindrical core] the shape of surface type of a device under test in the dense condition, the magnetic effect of the detection means which extends spacing of a cylindrical core and adjoins each other can be prevented maintaining such a dense condition.

[0047] Moreover, with surface type-like detection equipment according to claim 4, since the auxiliary core for flux path formation of the same width of face was formed in the both sides whose cylindrical cores were pinched in between about the direction of relative displacement with the cylindrical core several one [same] as a cylindrical core, it can become possible to wind an exiting coil around an auxiliary core, a detection means can arrange the exiting coil concerned independently, and the detection sensitivity of a line sensor can be raised.

[0048] In this case, while a cylindrical core and an auxiliary core are really formed from one magnetic material block, you may make it a device under test consist of a metal or magnetic material like surface type-like detection equipment according to claim 5.

[0049] Moreover, with surface type-like detection equipment according to claim 6, since the exiting coil is wound around the cylindrical core or the auxiliary core and a RF signal is impressed to an exiting coil, the magnetic flux which pierces through a device under test changes the short-time period corresponding to a RF signal, and detection of a fine concavo-convex configuration is attained.

[0050] Furthermore, since a device under test is a coin and the width of face at the head about the migration direction of a cylindrical core is 2mm or less, the concavo-convex configuration on the front face of a coin is detectable with the resolution required of distinction of a coin with surface type-like detection equipment according to claim 7. Moreover, the construction material of a coin, a diameter, etc. are detectable to the concavo-convex configuration and coincidence on the front face of a coin.

[0051] moreover, with surface type-like detection equipment according to claim 8 While arranging the head of the cylindrical core of arranged a large number on the same flat surface, the head of many cylindrical cores is made to counter the device-under-test front face which has irregularity in a field. spacing predetermined to a single tier -- alienation -- Since the detection means for detecting the flux reversal originated and generated in the concavo-convex configuration of a device under test at each of a cylindrical core is established and the concavo-convex configuration of the predetermined range of a device under test is detected from the output of this detection means A detection means can constitute a line sensor and the concavo-convex configuration of the front face of a device under test can be detected by non-contact in line. Moreover, since a detection means is formed in the cylindrical core arranged in the single tier and he is trying to detect magnetic variation, structure becomes easy and a manufacturing cost can be held down.

[0052] Moreover, since it was made smaller than the crevice or heights width of face of a concavo-convex configuration which is going to detect the width of face at the head of many cylindrical cores, the concavo-convex configuration of a device under test is detectable with resolution finer than the concavo-convex configuration of a device under test with surface type-like detection equipment according to claim 9. Moreover, since it considered as the magneto-resistive effect component attached in the sensing coil or cylindrical core around which the detection means was wound by the cylindrical core, change of the magnetic flux resulting from the concavo-convex configuration on the front face of a device under test is electrically detectable.

[0053] moreover -- surface type-like detection equipment according to claim 10 -- a single tier -- alienation -- since the concavo-convex configuration of the predetermined range of the direction which put two or more sets of cylindrical cores of arranged a large number in order, and was compared with the direction of a single tier two or more sets with the detection means was detected, a detection means is arranged two-dimensional in all directions, and the concavo-convex configuration of the predetermined range of the front face of a device under test can be detected by non-contact. Moreover, since a detection means is formed in the cylindrical core put in order two-dimensional and he is

trying to detect magnetic variation, structure becomes easy and a manufacturing cost can be held down.
[0054] moreover -- surface type-like detection equipment according to claim 11 -- a single tier -- alienation -- since the predetermined range formed by putting two or more sets of cylindrical cores of arranged a large number in order is set as the larger range than the magnitude of a device under test, the concavo-convex configuration of the whole device under test can be detected at once, without carrying out relative displacement of the head of the cylindrical core put in order in all directions to a device under test.
[0055] Moreover, with surface type-like detection equipment according to claim 12, since the auxiliary core for flux path formation of the same width of face was formed in the both sides whose cylindrical cores were pinched in between with the cylindrical core several one [same] as a cylindrical core, it can become possible to wind an exiting coil around an auxiliary core, a detection means can arrange the exiting coil concerned independently, and detection sensitivity can be raised.
[0056] Furthermore, with surface type-like detection equipment according to claim 13, since the exiting coil is wound around the cylindrical core or the auxiliary core and a RF signal is impressed to an exiting coil, the field which pierces through a device under test changes the short-time period corresponding to a RF signal, and detection of a fine concavo-convex configuration is attained.

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CLAIMS

[Claim(s)]
[Claim 1] While arranging the head of the cylindrical core of arranged a large number on the same flat surface, the head of the cylindrical core of above-mentioned a large number is made to counter the device-under-test front face which has irregularity in a field possible [the above-mentioned array direction] for relative displacement in the direction which intersects perpendicularly. spacing predetermined to a single tier -- alienation -- The detection means for detecting the flux reversal originated and generated at each of the above-mentioned cylindrical core in the above-mentioned concavo-convex configuration of the above-mentioned device under test is established. Surface type-like detection equipment which carries out A/D conversion of the output of this detection means to predetermined timing, and makes it the description as it comes to detect the concavo-convex configuration of the predetermined range from the data which stored in memory and were stored in this memory.
[Claim 2] It is surface type-like detection equipment according to claim 1 which makes it smaller than the width of face of the above-mentioned concavo-convex configuration where it detects the width of face about the above-mentioned relative-displacement direction at the head of the cylindrical core of above-mentioned a large number, and is characterized by the above-mentioned detection means being the magneto-resistive effect component attached in the sensing coil wound around the above-mentioned cylindrical core, or the above-mentioned cylindrical core.
[Claim 3] a up Norikazu train -- alienation -- the surface type-like detection equipment according to claim 1 or 2 characterized by having arranged so that the cylindrical core of arranged a large number may be put in order in the two or more set up diagnosis pair migration direction and the cylindrical core of a backside train may be located between the cylindrical cores of a before side train about the above-mentioned relative-displacement direction.
[Claim 4] Claims 1-3 characterized by coming to form the auxiliary core for flux path formation of the same width of face with the above-mentioned cylindrical core at the both sides whose above-mentioned cylindrical cores were pinched in between about the above-mentioned relative-displacement direction to several one [same] as the above-mentioned cylindrical core are surface type-like detection equipment of a publication either.
[Claim 5] The above-mentioned cylindrical core and an auxiliary core are surface type-like detection equipment according to claim 4 characterized by being what the above-mentioned device under test becomes from a metal or magnetic material while really being formed from one magnetic material block.
[Claim 6] Claims 1-5 characterized by the exiting coil being wound around the above-mentioned cylindrical core or the auxiliary core, and coming to impress a RF signal by the above-mentioned exiting coil are surface type-like detection equipment of a publication either.
[Claim 7] It is surface type-like detection equipment according to claim 6 which the above-mentioned device under test is a coin, and is characterized by the width of face about the above-mentioned relative-displacement direction at the head of the above-mentioned cylindrical core being 2mm or less.
[Claim 8] While arranging the head of the cylindrical core of arranged a large number on the same flat surface, the head of the cylindrical core of above-mentioned a large number is made to counter the device-under-test front face which has irregularity in a field. spacing predetermined to a single tier -- alienation -- Surface type-like detection equipment which makes it the description as the detection means for detecting the flux reversal originated and generated at each of the above-mentioned cylindrical core in the above-mentioned concavo-convex configuration of the above-mentioned device under test is established and it comes to detect the concavo-convex configuration of the predetermined range of the above-mentioned device under test from the output of this detection means.
[Claim 9] It is surface type-like detection equipment according to claim 8 which makes it smaller than the crevice or heights width of face of the above-mentioned concavo-convex configuration which is going to detect the width of face at the head of the cylindrical core of above-mentioned a large number, and is characterized by the above-mentioned detection means being the magneto-resistive effect component attached in the sensing coil wound around the above-

mentioned cylindrical core, or the above-[redacted]tioned cylindrical core.

[Claim 10] a up Norikazu train -- alienation -- the surface type-like detection equipment according to claim 8 or 9 characterized by detecting the concavo-convex configuration of the predetermined range of the direction which put two or more sets of cylindrical cores of arranged a large number in order, and was direction of up Norikazu train, and above-mentioned put in order two or more sets with the above-mentioned detection means.

[Claim 11] a up Norikazu train -- alienation -- the surface type-like detection equipment according to claim 10 characterized by setting the above-mentioned predetermined range formed by putting two or more sets of cylindrical cores of arranged a large number in order as the larger range than the magnitude of the above-mentioned device under test.

[Claim 12] Claims 8-11 characterized by coming to form the auxiliary core for flux path formation of the same width of face with the above-mentioned cylindrical core at the both sides whose above-mentioned cylindrical cores were pinched in between to several one [same] as the above-mentioned cylindrical core are surface type-like detection equipment of a publication either.

[Claim 13] Surface type-like detection equipment according to claim 12 characterized by winding the exiting coil around the above-mentioned cylindrical core or the auxiliary core, and impressing a RF signal to the above-mentioned exiting coil.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the outline configuration of the surface type-like detection equipment which applied this invention.
[Drawing 2] It is the decomposition perspective view of the line sensor of the surface type-like detection equipment of drawing 1 .
[Drawing 3] It is the top view of the line sensor of the surface type-like detection equipment of drawing 1 .
[Drawing 4] In order to explain the width of face w at the head of a cylindrical core, it is the perspective view showing some line sensors.
[Drawing 5] It is the circuit diagram showing the detection signal circuit of the surface type-like detection equipment of drawing 1 .
[Drawing 6] It is drawing showing the example of the output signal of the detection signal circuit of drawing 5 .
[Drawing 7] It is the conceptual diagram of detection by the line sensor of the surface type-like detection equipment of drawing 1 .
[Drawing 8] The perspective view in the condition that the outline of the production process of the core object of the surface type-like detection equipment of drawing 1 was shown, (a) processed the perspective view of a ferrite block into the ferrite block, and (b) processed the slot and the step, and (c) are the perspective views in the condition of having processed the cylindrical core and the auxiliary core into the ferrite block.
[Drawing 9] It is the perspective view showing another operation gestalt of the core object of the surface type-like detection equipment of drawing 1 .
[Drawing 10] It is the top view showing signs that the train of the cylindrical core of the surface type-like detection equipment of drawing 1 was put in order 2 sets.
[Drawing 11] It is drawing showing the sensor output at the time of measuring the concavo-convex configuration of a coin of 500 yen, having used width of face w of the apical surface of a cylindrical core as 0.5mm.
[Drawing 12] It is drawing showing the sensor output at the time of measuring the concavo-convex configuration of a coin of 500 yen, having used width of face w of the apical surface of a cylindrical core as 3mm.
[Drawing 13] It is for explaining the relation of the magnitude of the width of face w of the apical surface of a cylindrical core, and the width of face of the concavo-convex configuration of a device under test, and is the sectional view in which (A) shows the top view of a coin (device under test) of 1 yen, and (B) shows the dimension concept of the concavo-convex configuration of a coin of 1 yen.
[Description of Notations]
1 Line Sensor
2 Core Object
3 Cylindrical Core
3a Apical surface
5 Sensing Coil (Detection Means)
6 Exiting Coil
7 Auxiliary Core
10 Device under Test
14 RF Signal
25 Memory
29 A/D Converter
w Width of face about the device-under-test migration direction at the head of a cylindrical core

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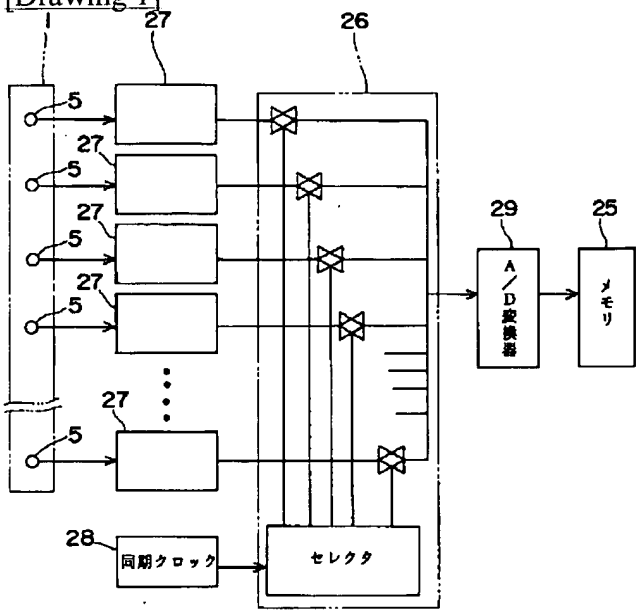
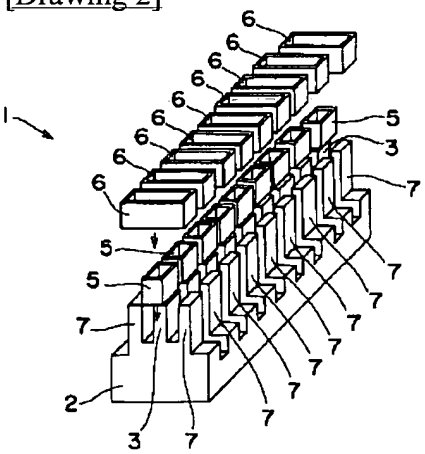
DRAWINGS

[Drawing 1]



[Drawing 2]



[Drawing 3]

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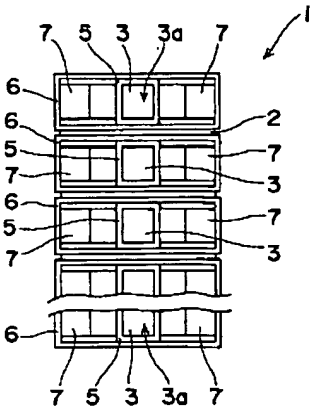
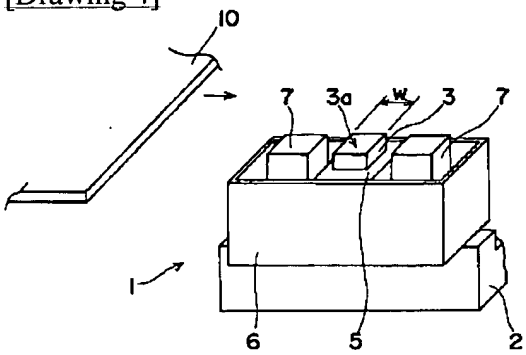
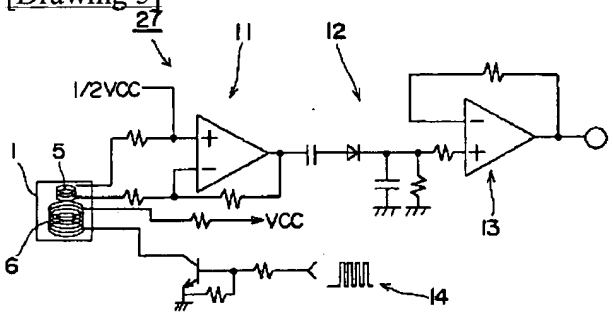


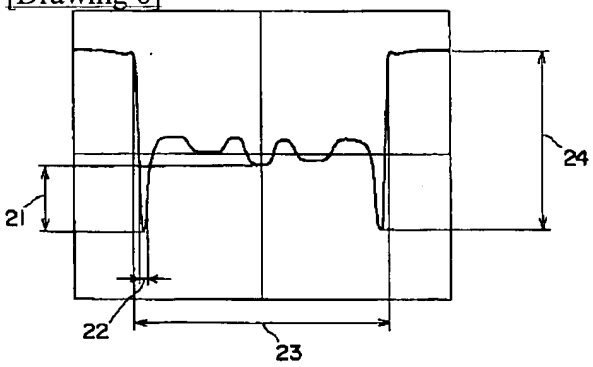
[Drawing 4]



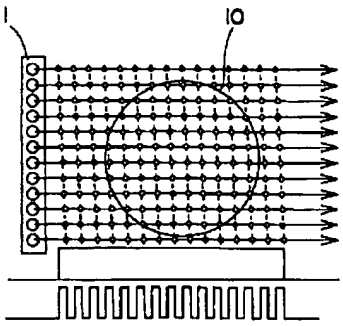
[Drawing 5]



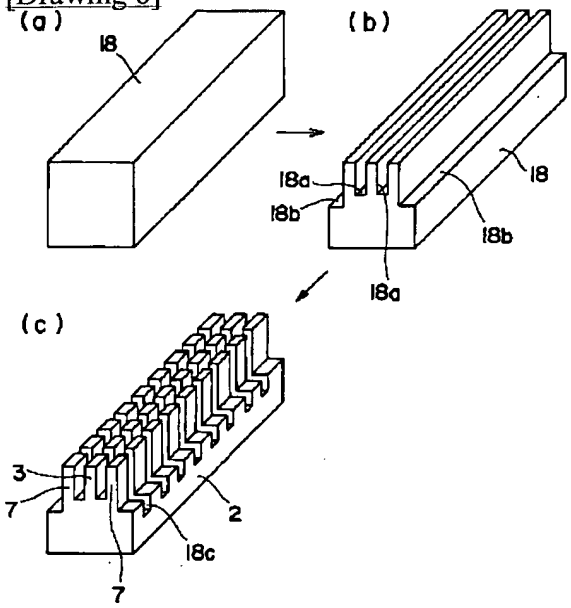
[Drawing 6]



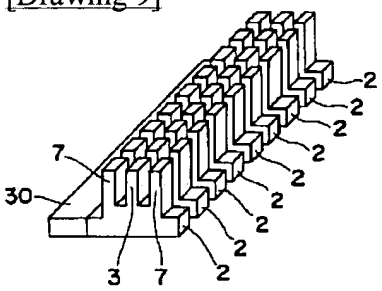
[Drawing 7]



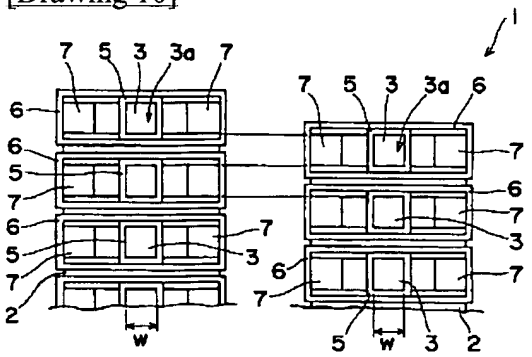
[Drawing 8]



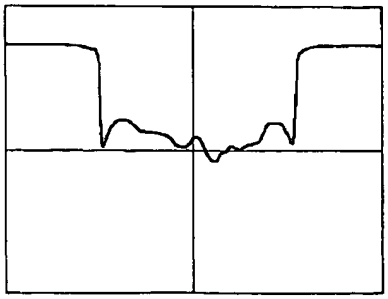
[Drawing 9]



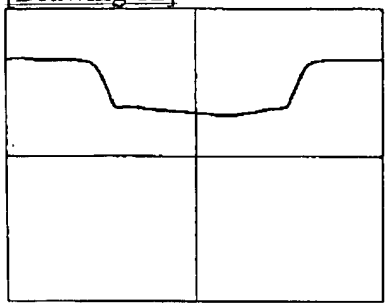
[Drawing 10]



[Drawing 11]

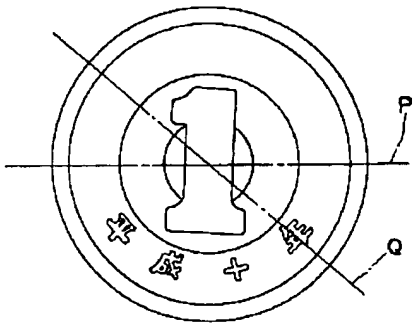


[Drawing 12]

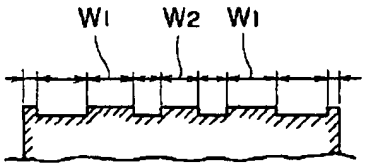


[Drawing 13]

(A)



(B)



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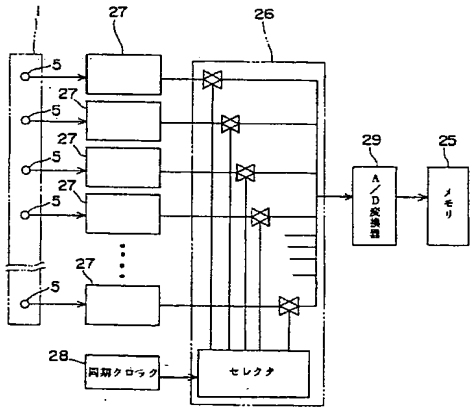
(54)【発明の名称】　表面形状検出装置

(57)【要約】

【課題】　被測定物の表面の凹凸形状を非接触で検出する。ラインセンサ１を構成して一度の相対移動で検出する。簡単な構造で安価に提供する。

【解決手段】　一列に所定の間隔で離間配列した多数の棒状コアの先端を同一平面上に配置するとともに多数の棒状コアの先端を磁界中において凹凸のある被測定物表面に上記配列方向とは直交する方向に相対移動可能に対向させ、棒状コアのそれぞれに被測定物の凹凸形状に起因して発生する磁束変化を検出するための検出コイル５を設け、検出コイル５の出力を所定のタイミングでＡ／Ｄ変換してメモリ２５に格納し、該メモリ２５に格納されたデータから所定範囲の凹凸形状を検出する。



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【特許請求の範囲】

【請求項１】　一列に所定の間隔で離間配列した多数の棒状コアの先端を同一平面上に配置するとともに上記多数の棒状コアの先端を磁界中において凹凸のある被測定物表面に上記配列方向とは直交する方向に相対移動可能に対向させ、上記棒状コアのそれぞれに上記被測定物の上記凹凸形状に起因して発生する磁束変化を検出するための検出手段を設け、該検出手段の出力を所定のタイミングでＡ／Ｄ変換してメモリに格納し、該メモリに格納されたデータから所定範囲の凹凸形状を検出するようにしてなることを特徴とする表面形状検出装置。

【請求項２】　上記多数の棒状コアの先端の上記相対移動方向に関する幅を検出しようとする上記凹凸形状の幅より小さくし、上記検出手段は上記棒状コアに巻回された検出コイル又は上記棒状コアに取り付けられた磁気抵抗効果素子であることを特徴とする請求項１記載の表面形状検出装置。

【請求項３】　上記一列に離間配列した多数の棒状コアを複数組上記相対移動方向に並べ、上記相対移動方向に関し前側列の棒状コアの間に後側列の棒状コアが位置するように配置したことを特徴とする請求項１又は２記載の表面形状検出装置。

【請求項４】　上記相対移動方向に関し上記棒状コアを間に挟んだ両側に上記棒状コアと同じ幅の磁束通路形成用の補助コアを上記棒状コアと同じ数一体に形成してなることを特徴とする請求項１から３のいずれか記載の表面形状検出装置。

【請求項５】　上記棒状コアと補助コアとは一つの磁性材ブロックより一体形成されるとともに、上記被測定物は金属又は磁性材からなるものであることを特徴とする請求項４記載の表面形状検出装置。

【請求項６】　上記棒状コア又は補助コアには励磁コイルが巻回されており、上記励磁コイルには高周波信号が印加されてなることを特徴とする請求項１から５のいずれか記載の表面形状検出装置。

【請求項７】　上記被測定物は硬貨であり、上記棒状コアの先端の上記相対移動方向に関する幅は２ｍｍ以下であることを特徴とする請求項６記載の表面形状検出装置。

【請求項８】　一列に所定の間隔で離間配列した多数の棒状コアの先端を同一平面上に配置するとともに上記多数の棒状コアの先端を磁界中において凹凸のある被測定物表面に対向させ、上記棒状コアのそれぞれに上記被測定物の上記凹凸形状に起因して発生する磁束変化を検出するための検出手段を設け、該検出手段の出力から上記被測定物の所定範囲の凹凸形状を検出するようにしてなることを特徴とする表面形状検出装置。

【請求項９】　上記多数の棒状コアの先端の幅を検出しようとする上記凹凸形状の凹部又は凸部幅より小さくし、上記検出手段は上記棒状コアに巻回された検出コイル又は上記棒状コアに取り付けられた磁気抵抗効果素子であることを特徴とする請求項８記載の表面形状検出装置。

【請求項１０】　上記一列に離間配列した多数の棒状コアを複数組並べ、上記検出手段により上記一列方向と上記複数組並べた方向の所定範囲の凹凸形状を検出するようにしたことを特徴とする請求項８又は９記載の表面形状検出装置。

【請求項１１】　上記一列に離間配列した多数の棒状コアを複数組並べることにより形成される上記所定範囲は、上記被測定物の大きさよりも大きい範囲に設定されていることを特徴とする請求項１０記載の表面形状検出装置。

【請求項１２】　上記棒状コアを間に挟んだ両側に上記棒状コアと同じ幅の磁束通路形成用の補助コアを上記棒状コアと同じ数一体に形成してなることを特徴とする請求項８から１１のいずれか記載の表面形状検出装置。

【請求項１３】　上記棒状コア又は補助コアには励磁コイルが巻回されており、上記励磁コイルには高周波信号が印加されることを特徴とする請求項１２記載の表面形状検出装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、磁束の変化に基づいて非接触で被測定物の表面の凹凸形状を検出する表面形状検出装置に関する。更に詳述すると、本発明は、被測定物を一度相対移動させるだけで所定範囲の被測定物の表面の凹凸形状を検出することができる表面形状検出装置に関するものである。

【０００２】

【従来の技術】従来、被測定物の表面の凹凸形状を精密に測定することができ、しかも簡単な構造且つ安価なものとしては、ダイヤルゲージがある。しかしながら、このダイヤルゲージは被測定物を固定し且つ測定子を凹凸面に接触させて測定を行うものであるため、その測定に長時間を要してしまう。このため、短時間に被測定物の表面の凹凸形状を検出することは困難であり、移動する被測定物の表面の凹凸形状を次々に検出する用途、例えば、自動販売機に組み込んだ硬貨識別装置等には適用することができなかった。

【０００３】そこで、例えば自動販売機に組み込まれた硬貨識別装置等では、複数のセンサ類を備えることで投入硬貨に対する様々な種類のデータを収集して硬貨の種類や真偽についての判別を行っている。硬貨識別装置に設置されるセンサ類の一つとしては渦電流型センサがある。この渦電流型センサは硬貨通路に対向して設置され、硬貨通過時の磁束変化を電気的に検出するものである。即ち、硬貨の材質や厚さによって抵抗率が異なるために、各硬貨毎に渦電流損失が異なる。かかる渦電流損失による磁束の変化を渦電流型センサは電気的に検出し

て出力する。したがって、硬貨判別装置は、渦電流型センサの検出出力の変化に基づいて投入された硬貨の材質、厚み、直径等を判断し、さらには他のセンサ類の検出出力に基づいたデータをも判断し、これらの結果を予め記憶しているデータと対比することで投入された硬貨の種類や真偽の判別を行っている。しかし、このような硬貨判別装置は構成が複雑で高コストである。

【０００４】

【発明が解決しようとする課題】一方、自動販売機等に組み込む硬貨識別装置等については、硬貨の変造・偽造がより精巧に成りつつある現状では、硬貨の表面に付されている複雑で細かい凹凸形状に基づいて硬貨の種類や真偽を判別したいとの要請がある。そこで、近年、被測定物の表面の凹凸形状を非接触で検出することができ、しかも構造が簡単で安価な表面形状検出装置の開発が要請されている。

【０００５】ここで、表面の凹凸形状を非接触で検出する方法として、ＣＣＤカメラで撮り込んだ画像を処理する方法や、半導体レーザを凹凸面に照射してその反射光をフォトダイオード等で取り込む方法等がある。しかしながら、ＣＣＤカメラで画像を撮り込む方法では、凹凸形状を平面的な画像データとして処理するので、例えば本物の硬貨の写真が貼られた偽物硬貨を区別することができず、また、光学的に凹凸情報を得易くするために周辺から浅い角度で光を照射する場合には、中心部が窪んでいると反射光が得難くて陰になり、この窪みを孔と誤認する虞がある。また、半導体レーザの反射光をフォトダイオード等で取り込む方法では、レーザ光線を面状に走査させる必要がある。さらに、これら両方の方法では凹凸面の錆や汚れ等が千差万別で識別の障害となり、また、硬貨表面の凹凸形状を検出するために凹凸形状専用の高価な装置類を別個に設置することになるので製造コストの増加及び装置の大型化を招き妥当でない。したがって、硬貨識別装置等では、従来から備えていた材質等を検出する既存のセンサを発展させて硬貨表面の凹凸形状の検出を可能にし、硬貨の材質等のデータと一緒に硬貨表面の凹凸形状に関するデータを得ることができれば便宜である。

【０００６】そして、かかる表面形状検出装置の開発は、硬貨識別の用途に限らず他の用途でも要請されている。

【０００７】本発明は、被測定物の表面の凹凸形状を非接触で検出することが可能で、しかも簡単な構造で安価に製造することができる表面形状検出装置を提供することを目的とする。

【０００８】

【課題を解決するための手段】かかる目的を達成するために請求項１記載の表面形状検出装置は、一列に所定の間隔で離間配列した多数の棒状コアの先端を同一平面上に配置するとともに多数の棒状コアの先端を磁界中において凹凸のある被測定物表面に配列方向とは直交する方向に相対移動可能に対向させ、棒状コアのそれぞれに被測定物の凹凸形状に起因して発生する磁束変化を検出するための検出手段を設け、該検出手段の出力を所定のタイミングでＡ／Ｄ変換してメモリに格納し、該メモリに格納されたデータから所定範囲の凹凸形状を検出するようにしたものである。

【０００９】したがって、検出手段は被測定物との相対移動方向に対して直交する方向に一列に並べられたラインセンサを構成する。各検出手段の出力は棒状コアの先端が対向する被測定物の表面の凹凸形状に応じて変化するので、被測定物をラインセンサに対して相対移動させながら各検出手段の出力を所定のタイミングで次々にサンプリングすることで、一度の相対移動で被測定物の凹凸形状を表面全体的に検出することができる。各検出手段の出力はアナログ信号であるが、Ａ／Ｄ変換することで信号処理に適したデジタル信号に変換されメモリされる。

【００１０】また、請求項２記載の表面形状検出装置は、多数の棒状コアの先端の相対移動方向に関する幅を検出しようとする凹凸形状の幅より小さくし、検出手段を棒状コアに巻回された検出コイル又は棒状コアに取り付けられた磁気抵抗効果素子としている。検出手段は棒状コアに影響する磁束の変化を検出するので、棒状コアの先端の細さによってセンサとしての分解能が決定される。即ち、棒状コアの先端の相対移動方向に関する幅を検出しようとする凹凸形状の幅より小さくすることで、この凹凸形状よりも細かい分解能で被測定物の凹凸形状を検出する。また、各検出手段として検出コイル又は磁気抵抗効果素子を使用することで、被測定物表面の凹凸形状に起因した磁束の変化を電気的に検出する。

【００１１】また、請求項３記載の表面形状検出装置は、一列に離間配列した多数の棒状コアを複数組相対移動方向に並べ、相対移動方向に関し前側列の棒状コアの間に後側列の棒状コアが位置するように配置したものである。したがって、一列に配列した棒状コアの組を増やしても被測定物を相対移動させた場合の棒状コアの軌跡は重ならず、当該軌跡の間隔を狭めた密な状態で被測定物の表面形状の検出を行うことができる。また、隣り合う検出手段同士の磁気的干渉を防止するために同一組内の棒状コアの間隔を広く設定しても、棒状コアの組の数を増やすことで全体として密な状態で被測定物の表面形状の検出を行うことができる。

【００１２】また、請求項４記載の表面形状検出装置は、相対移動方向に関し棒状コアを間に挟んだ両側に棒状コアと同じ幅の磁束通路形成用の補助コアを棒状コアと同じ数一体に形成したものである。したがって、検出手段の設けられている棒状コアとは別に補助コアが形成されることになり、この補助コアに被測定物が通過する磁界を発生させる励磁コイルを巻回することで励磁コイ

ルを検出手段から独立して配置することができる。

【００１３】この場合、請求項５記載の表面形状検出装置のように、棒状コアと補助コアとは一つの磁性材ブロックより一体形成されるとともに、被測定物は金属又は磁性材からなるものでも良い。

【００１４】また、請求項６記載の表面形状検出装置は、棒状コア又は補助コアには励磁コイルが巻回されており、励磁コイルには高周波信号を印加したものである。したがって、被測定物を貫く磁束が高周波信号に対応する短時間周期で変化し、細かい凹凸形状の検出が可能になる。

【００１５】さらに、請求項７記載の表面形状検出装置は、被測定物は硬貨であり、棒状コアの先端の相対移動方向に関する幅は２ｍｍ以下としたものである。検出手段は棒状コアに影響する磁束の変化を検出するので、棒状コアの先端の太さによってセンサの分解能が決定される。硬貨の表面には細かい凹凸形状が形成されているが、棒状コアの先端の相対移動方向に関する幅を２ｍｍ以下にすることで、硬貨の判別に要求される分解能で硬貨表面の凹凸形状を検出することができる。

【００１６】また、請求項８記載の表面形状検出装置は、一列に所定の間隔で離間配列した多数の棒状コアの先端を同一平面上に配置するとともに多数の棒状コアの先端を磁界中において凹凸のある被測定物表面に対向させ、棒状コアのそれぞれに被測定物の凹凸形状に起因して発生する磁束変化を検出するための検出手段を設け、該検出手段の出力から被測定物の所定範囲の凹凸形状を検出するようにしたものである。したがって、検出手段は被測定物に対向させて使用するラインセンサを構成する。各検出手段の出力は棒状コアの先端が対向する被測定物の表面の凹凸形状に応じて変化するので、被測定物の表面の各検出手段が対向する位置の凹凸形状を検出することができる。

【００１７】また、請求項９記載の表面形状検出装置は、多数の棒状コアの先端の幅を検出しようとする凹凸形状の凹部又は凸部幅より小さくし、検出手段を棒状コアに巻回された検出コイル又は棒状コアに取り付けられた磁気抵抗効果素子としている。検出手段は棒状コアに影響する磁束の変化を検出するので、棒状コアの先端の細さによってセンサとしての分解能が決定される。即ち、棒状コアの先端の幅を検出しようとする凹凸形状の凹部又は凸部幅より小さくすることで、この凹凸形状よりも細かい分解能で被測定物の凹凸形状を検出する。また、各検出手段として検出コイル又は磁気抵抗効果素子を使用することで、被測定物表面の凹凸形状に起因した磁束の変化を電気的に検出する。

【００１８】また、請求項１０記載の表面形状検出装置は、一列に離間配列した多数の棒状コアを複数組並べ、検出手段により一列方向と複数組並べた方向の所定範囲の凹凸形状を検出するものである。したがって、検出手段が縦横に２次元的に配置されることになり、棒状コアの先端を被測定物に対して相対移動させることなく被測定物の所定範囲の凹凸形状を一度に検出することができる。

【００１９】また、請求項１１記載の表面形状検出装置は、一列に離間配列した多数の棒状コアを複数組並べることにより形成される所定範囲を、被測定物の大きさよりも大きい範囲に設定している。したがって、棒状コアの先端を被測定物に対して相対移動させることなく被測定物の表面全体の凹凸形状を一度に検出することができる。

【００２０】また、請求項１２記載の表面形状検出装置は、棒状コアを間に挟んだ両側に棒状コアと同じ幅の磁束通路形成用の補助コアを棒状コアと同じ数一体に形成したものである。したがって、検出手段の設けられている棒状コアとは別に補助コアが形成されることになり、この補助コアに被測定物が通過する磁界を発生させる励磁コイルを巻回することで励磁コイルを検出手段から独立して配置することができる。

【００２１】さらに、請求項１３記載の表面形状検出装置は、棒状コア又は補助コアには励磁コイルが巻回されており、励磁コイルには高周波信号を印加したものである。したがって、被測定物を貫く磁界が高周波信号に対応する短時間周期で変化し、細かい凹凸形状の検出が可能になる。

【００２２】

【発明の実施の形態】以下、本発明の構成を図面に示す最良の形態に基づいて詳細に説明する。

【００２３】図１から図３に、本発明を適用した表面形状検出装置の実施形態の一例を示す。この表面形状検出装置は、一列に所定の間隔で離間配列した多数の棒状コア３の先端を同一平面上に配置するとともに多数の棒状コア３の先端を磁界中において凹凸のある被測定物１０の表面に上記棒状コア３の先端の配列方向とは直交する方向に相対移動可能に対向させ、棒状コア３のそれぞれに被測定物１０の凹凸形状に起因して発生する磁束変化を検出するための検出手段５を設け、検出手段５の出力を所定のタイミングでＡ／Ｄ変換してメモリ２５に格納し、該メモリ２５に格納されたデータから被測定物１０の所定範囲における凹凸形状を検出するものである。

【００２４】ここで、凹凸を有するとともに金属又は磁性材からなる被測定物１０が上記棒状コア３の先端の配列方向とは直交する方向に相対移動する場合についての動作を一つの棒状コア３を用いて説明する。

【００２５】いま、図４に示すように、被測定物１０の相対移動方向が図４中矢印方向であったとすると、各棒状コア３の先端面３ａの当該移動方向に関する幅ｗ、即ち棒状コア３の先端面３ａの四辺のうち当該相対移動方向に沿う二辺の長さｗは、検出しようとする凹凸形状の幅よりも小さく設定されている。例えば被測定物１０が

硬貨の場合には、硬貨１０の表面の検出しようとする凹凸形状の凹部又は凸部の幅よりも小さな値、例えば２ｍｍ以下の値に、上記棒状コア３の先端面３ａの当該相対移動方向に沿う長さｗを設定しておく。なお、検出しようとする凹凸形状の凹部又は凸部の幅よりも小さな値とは、必ずしも最小の凹部又は凸部の幅より小さいことを意味するものではなく、検出しようとする幅に基づき必要とする分解能が得られるように定めればよい。被測定物１０が硬貨の場合、上記幅ｗが２ｍｍよりも大きくなると、一般に硬貨１０の表面の凹凸形状に対して検出の分解能が粗くなって細かい凹凸形状の検出が困難になり、硬貨１０の真偽等判別に用いるデータとしては分解能が２ｍｍ以下の場合に比較して劣るものとなってしまう。ただし、必ずしも幅ｗを２ｍｍ以下にする必要はなく、検出しようとする被測定物１０の凹凸形状の幅と必要な分解能とに応じて幅ｗを設定することが重要である。

【００２６】また、凹凸形状を大まかに検出すれば良い場合には上記幅ｗを凹凸形状の幅よりも小さく設定する必要はなく、凹凸形状の幅に近い寸法や若干大きくても検出に要求される分解能を満足すれば問題はない。

【００２７】被測定物１０における検出しようとする凹凸形状には種々の幅の凹凸が混在している場合が多いが、一般的には凹凸形状の最小の幅を基準にして棒状コア３の幅ｗを設定するのが良い。例えば、図１３（Ａ）に示す１円硬貨（材質：アルミ）の凹凸形状を検出する場合には、（Ｂ）に示すように、細かい文字を除外した検出すべき凹凸形状の最小の幅は外縁の凸部分であるので、この外縁の凸部分を基準に幅ｗを設定する。かかる最小の幅を基準にしてこれよりも小さい値に幅ｗを設定しておけば、全ての凹凸形状の検出が可能になる。このようにすることで、棒状コア３の相対移動軌跡が例えば図１３（Ａ）のＰ線であってもＱ線であっても凹凸形状の検出を良好に行うことができる。ただし、必ずしも外縁の凸部分を基準にしてこれよりも小さい値に幅ｗを設定する必要はなく、例えば外縁の凸部分の形状検出を行わずに模様部分の凹凸形状の検出を行えば良い場合には、検出対象である模様部分の凹凸形状の幅のうち最も小さい幅よりも棒状コア３の幅ｗを小さくすれば良い。例えば図１３（Ｂ）の場合では、検出しようとする凹凸形状の幅、例えば凸部の幅Ｗ１，Ｗ２よりも棒状コア３の幅ｗを小さな値にしておけば良い。即ち、検出したい凹凸形状のうち、どの大きさの幅まで検出したいかを決め、その幅よりも小さくなるようにすれば良い。この場合には、検出したい大きさの幅の凹凸については鮮明に検出することができる一方、検出する必要のない小さな幅の凹凸についても概略形状の把握は可能である。

【００２８】検出手段５は、例えば棒状コア３に巻回された検出コイルである。また、上記相対移動方向に関し棒状コア３を間に挟んだ両側には棒状コア３と同じ幅の磁束通路形成用の補助コア７が棒状コア３と同じ数一体に形成されており、これら両側の補助コア７には励磁コイル６が巻回されている。なお、必ずしも補助コア７を棒状コイル３の両側に形成する必要はなく、いずれか一方にのみ補助コア７を形成するようにしても良い。また、両側の補助コア７の形成を省略しても良く、この場合には棒状コア３に励磁コイル６を巻回すれば良い。

【００２９】図５に示すように、各励磁コイル６には高周波信号１４が励磁信号として印加され、被測定物１０が相対移動する空間に磁界を発生させる。この磁界中を金属部などを有する被測定物１０が通過すると磁束が変化する。この磁束の変化は棒状コア３の先端面３ａと被測定物１０との間隔や被測定物１０の金属の材質によってその変化の度合いが変わるので、被測定物１０の表面の凹凸形状や材質に応じて検出コイル５の出力が変化する。各検出コイル５の出力は検出信号回路２７のアンプ回路１１によって増幅された後、検波回路１２及びピークホールド回路１３によって半波整流されて包絡線検波され、被測定物１０の凹凸形状に比例した波形のアナログ信号となる。なお、増幅と検波の順序は逆でも良い。そして図１に示すように、全ての検出コイル５のアナログ信号はアナログマルチプレクサ２６に供給される。アナログマルチプレクサ２６は、各検出コイル５のアナログ信号を同期クロック２８からのパルスに基づいた所定のタイミングで順番にＡ／Ｄ変換器２９に供給する。Ａ／Ｄ変換器２９によって変換されたデジタル信号は、メモリ２５に順次格納される。なお、被測定物１０が例えば金属等の場合には当該被測定物１０に発生する渦電流が棒状コア３に影響する磁束を減少させるので検出コイル５の出力信号が変化することになり、また、被測定物１０が例えば磁性体等の場合には当該被測定物１０からの磁束の漏れが減少するので検出コイル５の出力信号が変化することになり、したがって、本発明の表面形状検出装置では、被測定物１０が金属等である場合に限らず磁性体等であっても表面の凹凸形状を検出することができる。

【００３０】この表面形状検出装置では、各コア３，７及び各コイル５，６が相対移動方向に対して直交する方向に一列に離間配列されており、ラインセンサ１を構成している。そして、このラインセンサ１は、各励磁コイル６が発生させる磁界中を被測定物１０が相対移動するように配置される。例えば自動販売機の硬貨識別装置等に組み込まれる硬貨識別用のセンサとして使用する場合には、硬貨通路の近傍にラインセンサ１を配置し各励磁コイル６が発生させる磁界中を硬貨が通過するようにする。

【００３１】いま、ラインセンサ１の長手方向中央に位置する棒状コア３に設けられた検出コイル５に関して、即ち被測定物としての硬貨１０が相対移動する際にその中心位置に対向する棒状コア３に設けられた検出コイル

５に関して検討すると、この検出コイル５に対応する検出信号回路２７からは、硬貨１０の相対移動に伴って、例えば図６に示す出力信号が得られる。この出力信号は硬貨１０の凸部に対応して低くなり、凹部に対応して高くなる。そして、硬貨１０が棒状コア３に対向するまでは凹部に対応している場合よりも更に出力は高くなり、途中に孔が在れば同様の出力が得られる。即ち、この出力信号の波形は硬貨１０の表面の凹凸形状に対応するものであるが、同時に、硬貨１０の縁部と中央部の高さの差に関する情報２１、縁部の幅に関する情報２２、直径に関する情報２３、材質や厚みに関する情報２４等を得ることができる。したがって、硬貨識別用のセンサとして使用した場合には、表面の凹凸形状についての情報に加えてこれらの情報２１～２４を同時に検出することができる。

【００３２】このように、ラインセンサ１を構成する検出コイル５に接続された検出信号回路２７の各々からは、対応する棒状コア３の相対移動軌跡に沿う硬貨１０の表面の凹凸形状に比例した波形のアナログ信号がそれぞれ出力される。各検出信号回路２７の出力信号は、アナログマルチプレクサ２６及びＡ／Ｄ変換器２９により所定のタイミングで順番にＡ／Ｄ変換されてメモリ２５に記憶される。即ち、図７に丸印で示すように、硬貨１０とラインセンサ１とを一度相対移動させれば、硬貨１０の表面の凹凸形状についてのデータがメッシュ状にサンプリングされ、硬貨１０の表面を全体的に検出することができる。即ち、ラインセンサ１が相対移動する範囲の凹凸形状が検出される。なお、ラインセンサ１を硬貨識別用のセンサとして使用することは一例であって硬貨識別の用途に限るものではないことは勿論である。

【００３３】上記のように、ラインセンサ１の出力を用いれば、図７に丸印で示すように、硬貨１０とラインセンサ１との一度の相対移動で、硬貨１０の表面の凹凸形状についてのデータがメッシュ状にサンプリングされ、硬貨１０の表面を全体的に検出することができるが、必要に応じて、硬貨１０の中央部がラインセンサ１を通過するときの一時点において、又は、このとき硬貨１０の移動を一旦停止させて、この時のラインセンサ１を構成する各検出コイル５からの検出信号を検出しても、硬貨１０の中央部における縦方向の凹凸形状についての検出結果を得ることができる。この時の凹凸形状についての検出結果は、図１３（Ａ）においては、硬貨の中心を通る縦方向の凹凸形状を検出することができる。

【００３４】また、ラインセンサ１を多数横方向に、検出しようとする領域全体を含むように、或いは硬貨１０より大きい領域が形成されるように、隣接状態に並べ、その領域内に硬貨１０の所定位置又は全体が入ったときに、硬貨の移動を停止させ、それぞれのラインセンサ１を構成する各検出コイル５からの検出信号を検出するようにしておけば、停止状態でも硬貨１０の表面を全体的に検出することができる。このとき、横方向に配置するラインセンサを図１０に示すように一つずつ位置をずらせて並べるようにすれば、全体の凹凸形状をより均一的に検出することができる。

【００３５】即ち、上述の棒状コア３を縦横に２次元的に配置することで、棒状コア３を被測定物１０に対して相対的に移動させなくても被測定物１０の表面形状を一度に検出することが出来るようになる。

【００３６】本実施形態の表面形状検出装置は、直方体形状のフェライトブロック１８より多数の棒状コア３及び補助コア７を一体形成することでラインセンサ１を構成している。つまり、図８に示すように、先ず（ａ）に示すフェライトブロック１８に長手方向に沿った溝１８ａと段部１８ｂを機械加工して（ｂ）に示す状態にする。次に、このフェライトブロック１８に適当な間隔で溝１８ｃを所定数機械加工して（ｃ）に示すように各棒状コア３と各補助コア７とが一体形成されたコア体２を製造する。このように多数の棒状コア３及び補助コア７を機械加工によって一体形成すれば、基部側は一つのブロックとして連結した状態で構成できるので、多数の棒状コア３及び補助コア７を所定間隔で正確に配置することができる。

【００３７】ただし、必ずしも各棒状コア３及び補助コア７を１個のフェライトブロック１８から一体形成する必要はなく、図８（ａ）に示すフェライトブロックより短いフェライトブロック１８に所定数だけ棒状コア３及び補助コア７を形成したものを複数個接合して所定長のラインセンサ１を構成しても良い。又は、図９に示すように、１本の棒状コア３と２本の補助コア７が形成されたコア体２を多数並べ、例えばセラミック板３０に接合することで一体化してラインセンサ１を構成しても良い。

【００３８】なお、上述の各形態は本発明の好適な形態の例ではあるがこれらに限定されるものではなく本発明の要旨を逸脱しない範囲において種々変形実施可能である。例えば、上述の説明では被測定物として硬貨を説明したが、本発明は、材質が金属や磁性体等からなる種々のものの表面の凹凸形状を検出することができる。

【００３９】また、棒状コア３等を一列に並べてラインセンサ１を構成しているが、棒状コア３を複数列並べてラインセンサ１を構成しても良い。即ち、一列に離間配列した多数の棒状コア３を複数組被測定物１０の相対移動方向に並べ、この相対移動方向に関し前側列の棒状コア３の間に後側列の棒状コア３が位置するように配置しても良い。図１０に、一列に離間配列した多数の棒状コア３を例えば二組被測定物１０の相対移動方向に並べ、１列目の棒状コア３の間に２列目の棒状コア３が位置するように配置した様子を示す。１列目の棒状コア３と２列目の棒状コア３とを交互に配置しているので、各列の棒状コア３の相対移動軌跡は重ならず、棒状コア３の数

を増やして密な状態で被測定物１０の表面形状の検出を行うことができる。例えば、構造上、加工上の制約等から一列の棒状コア３の間隔をあまり狭くできない場合や、隣り合う検出コイル５の磁気的干渉を防止するために棒状コア３の間隔を広くせざるをえない場合であっても、棒状コア３の列を増やすことで棒状コア３の相対移動軌跡を密な状態にして被測定物１０の検出を行うことができる。

【００４０】また、上述の説明では、検出手段が棒状コア３に巻回された検出コイル５としたが、検出コイル５に代えて凹凸形状に起因した磁束の変化を検出するための磁気抵抗効果素子を棒状コア３に取り付けても良い。

【００４１】また、上述の説明では２つのコイル、即ち検出コイル５と励磁コイル６を備えていたが、必ずしも２つのコイル５，６を備える必要はなく、これらを１つのコイルにして構成しても良い。この場合には、１つのコイルによって励磁を行うと同時に当該コイルにおけるインダクタンス変化を検出できるように回路構成をし、この検出結果に基づいて磁束の変化を検出するようにすれば良い。

【００４２】さらに、励磁コイル６に印加する信号としては、必ずしも高周波信号に限るものではなく、被測定物１０やその検出の分解能等に応じた信号を用いればよい。ただし、硬貨識別用のセンサとして使用する場合には、１ｋＨｚから１０ＭＨｚの周波数の交流信号の使用が好ましい。１ｋＨｚ未満では、硬貨の種類や真偽等を判別するためのデータとしては分解能に劣るものになるからであり、１０ＭＨｚを越えると、インピーダンスが上昇し、センサの駆動が困難となったり、磁気回路を介さない信号配線間での飛び込みノイズが大きくなるからである。

【００４３】

【実施例】次に、棒状コア３の先端面３ａの幅ｗと凹凸形状検出の分解能との関係を調べるために、幅ｗの値を変えて５００円硬貨（材質：白銅）の表面形状を検出する実験を行った。検出したい凹凸の幅が約１ｍｍであるときに、図１１に幅ｗを０．５ｍｍとした場合の検出コイル５の出力信号の波形を、図１２に幅ｗを３ｍｍとした場合の検出コイル５の出力信号の波形を示す。幅ｗを３ｍｍとした場合（図１２）には、出力信号の波形が全体的に平らなものとなってしまい、５００円硬貨の縁部と中央部の高さの差に関する情報２１（図６参照）、直径に関する情報２３、材質の厚みに関する情報２４等は確認可能であるが、表面の凹凸形状の検出は困難であった。これに対し、幅ｗを０．５ｍｍとした場合（図１１）には、出力信号の形状の変化が５００円硬貨の表面形状の変化に良好に追従している。これにより、幅ｗを小さくすることで細かい凹凸形状の特徴をより良好に検出できることが確認できた。また、幅ｗを０．５ｍｍとすることで、硬貨の種類や真偽等を判別するためのセンサとして使用するのに十分な分解能を得ることできることがわかった。

【００４４】

【発明の効果】以上説明したように、請求項１記載の表面形状検出装置では、一列に所定の間隔で離間配列した多数の棒状コアの先端を同一平面上に配置するとともに多数の棒状コアの先端を磁界中において凹凸のある被測定物表面に配列方向とは直交する方向に相対移動可能に対向させ、棒状コアのそれぞれに被測定物の凹凸形状に起因して発生する磁束変化を検出するための検出手段を設け、該検出手段の出力を所定のタイミングでＡ／Ｄ変換してメモリに格納し、該メモリに格納されたデータから所定範囲の凹凸形状を検出するので、検出手段がラインセンサを構成し、１回の走査で被測定物の表面全体の凹凸形状を非接触で検出することができる。また、一列に並べた棒状コアに検出手段を設けて磁気変化を検出するようにしているので、ラインセンサの構造が簡単なものとなり、製造コストを抑えることができる。

【００４５】また、請求項２記載の表面形状検出装置では、多数の棒状コアの先端の相対移動方向に関する幅を検出しようとする凹凸形状の幅より小さくしたので、被測定物の凹凸形状よりも細かい分解能で被測定物の凹凸形状を検出することができる。また、検出手段を棒状コアに巻回された検出コイル又は棒状コアに取り付けられた磁気抵抗効果素子としたので、被測定物表面の凹凸形状に起因した磁束の変化を電気的に検出することができる。

【００４６】また、請求項３記載の表面形状検出装置では、一列に離間配列した多数の棒状コアを複数組上記相対移動方向に並べ、上記相対移動方向に関し前側列の棒状コアの間に後側列の棒状コアが位置するように配置したので、棒状コアの数を増やして密な状態で被測定物の表面形状の検出を行うことが可能になると共に、このような密な状態を維持しながら棒状コアの間隔を広げて隣り合う検出手段の磁気的影響を防止することができる。

【００４７】また、請求項４記載の表面形状検出装置では、相対移動方向に関し棒状コアを間に挟んだ両側に棒状コアと同じ幅の磁束通路形成用の補助コアを棒状コアと同じ数一体に形成したので、補助コアに励磁コイルを巻回することが可能になって当該励磁コイルを検出手段とは独立して配置することができ、ラインセンサの検出感度を向上させることができる。

【００４８】この場合、請求項５記載の表面形状検出装置のように、棒状コアと補助コアとが一つの磁性材ブロックより一体形成されるとともに、被測定物が金属又は磁性材からなるようにしても良い。

【００４９】また、請求項６記載の表面形状検出装置では、棒状コア又は補助コアには励磁コイルが巻回されており、励磁コイルには高周波信号が印加されるので、被測定物を貫く磁束が高周波信号に対応する短時間周期で

変化し、細かい凹凸形状の検出が可能になる。

【００５０】さらに、請求項７記載の表面形状検出装置では、被測定物は硬貨であり、棒状コアの移動方向に関する先端の幅が２ｍｍ以下であるので、硬貨の判別に要求される分解能で硬貨表面の凹凸形状を検出することができる。また、硬貨表面の凹凸形状と同時に、硬貨の材質，直径等も検出することができる。

【００５１】また、請求項８記載の表面形状検出装置では、一列に所定の間隔で離間配列した多数の棒状コアの先端を同一平面上に配置するとともに多数の棒状コアの先端を磁界中において凹凸のある被測定物表面に対向させ、棒状コアのそれぞれに被測定物の凹凸形状に起因して発生する磁束変化を検出するための検出手段を設け、該検出手段の出力から被測定物の所定範囲の凹凸形状を検出するので、検出手段がラインセンサを構成し、被測定物の表面の凹凸形状を線的に非接触で検出することができる。また、一列に並べた棒状コアに検出手段を設けて磁気変化を検出するようにしているので、構造が簡単になり、製造コストを抑えることができる。

【００５２】また、請求項９記載の表面形状検出装置では、多数の棒状コアの先端の幅を検出しようとする凹凸形状の凹部又は凸部幅より小さくしたので、被測定物の凹凸形状よりも細かい分解能で被測定物の凹凸形状を検出することができる。また、検出手段を棒状コアに巻回された検出コイル又は棒状コアに取り付けられた磁気抵抗効果素子としたので、被測定物表面の凹凸形状に起因した磁束の変化を電気的に検出することができる。

【００５３】また、請求項１０記載の表面形状検出装置では、一列に離間配列した多数の棒状コアを複数組並べ、検出手段により一列方向と複数組並べた方向の所定範囲の凹凸形状を検出するようにしたので、検出手段が縦横に２次元的に配置され、被測定物の表面の所定範囲の凹凸形状を非接触で検出することができる。また、２次元的に並べた棒状コアに検出手段を設けて磁気変化を検出するようにしているので、構造が簡単になり、製造コストを抑えることができる。

【００５４】また、請求項１１記載の表面形状検出装置では、一列に離間配列した多数の棒状コアを複数組並べることにより形成される所定範囲を、被測定物の大きさよりも大きい範囲に設定しているので、縦横に並べた棒状コアの先端を被測定物に対して相対移動させることなく被測定物全体の凹凸形状を一度に検出することができる。

【００５５】また、請求項１２記載の表面形状検出装置では、棒状コアを間に挟んだ両側に棒状コアと同じ幅の磁束通路形成用の補助コアを棒状コアと同じ数一体に形成したので、補助コアに励磁コイルを巻回することが可能になって当該励磁コイルを検出手段とは独立して配置することができ、検出感度を向上させることができる。

【００５６】さらに、請求項１３記載の表面形状検出装置では、棒状コア又は補助コアには励磁コイルが巻回されており、励磁コイルには高周波信号が印加されるので、被測定物を貫く磁界が高周波信号に対応する短時間周期で変化し、細かい凹凸形状の検出が可能になる。

【図面の簡単な説明】

【図１】本発明を適用した表面形状検出装置の概略構成を示すブロック図である。

【図２】図１の表面形状検出装置のラインセンサの分解斜視図である。

【図３】図１の表面形状検出装置のラインセンサの平面図である。

【図４】棒状コアの先端の幅ｗを説明するためにラインセンサの一部分を示す斜視図である。

【図５】図１の表面形状検出装置の検出信号回路を示す回路図である。

【図６】図５の検出信号回路の出力信号の例を示す図である。

【図７】図１の表面形状検出装置のラインセンサによる検出の概念図である。

【図８】図１の表面形状検出装置のコア体の製造工程の概略を示し、（ａ）はフェライトブロックの斜視図、（ｂ）はフェライトブロックに溝及び段部を加工した状態の斜視図、（ｃ）はフェライトブロックに棒状コア及び補助コアを加工した状態の斜視図である。

【図９】図１の表面形状検出装置のコア体の別の実施形態を示す斜視図である。

【図１０】図１の表面形状検出装置の棒状コアの列を２組並べた様子を示す平面図である。

【図１１】棒状コアの先端面の幅ｗを０．５ｍｍとして５００円硬貨の凹凸形状を測定した場合のセンサ出力を示す図である。

【図１２】棒状コアの先端面の幅ｗを３ｍｍとして５００円硬貨の凹凸形状を測定した場合のセンサ出力を示す図である。

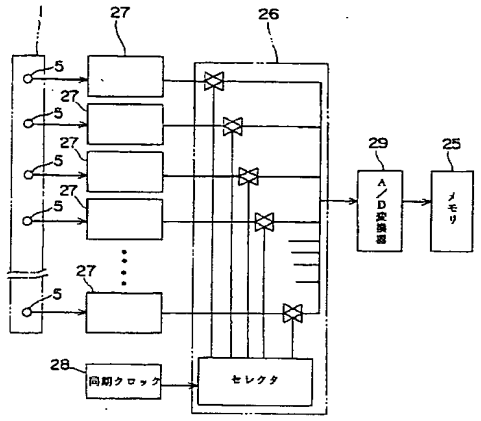
【図１３】棒状コアの先端面の幅ｗと被測定物の凹凸形状の幅との大きさの関係を説明するためのもので、（Ａ）は１円硬貨（被測定物）の平面図、（Ｂ）は１円硬貨の凹凸形状の寸法概念を示す断面図である。

【符号の説明】

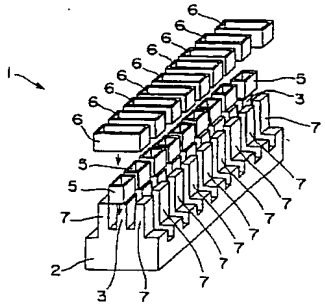
１　ラインセンサ
２　コア体
３　棒状コア
３ａ　先端面
５　検出コイル（検出手段）
６　励磁コイル
７　補助コア
１０　被測定物
１４　高周波信号
２５　メモリ
２９　Ａ／Ｄ変換器

w　棒状コアの先端の被測定物移動方向に関する幅

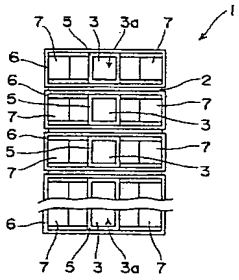
【図１】



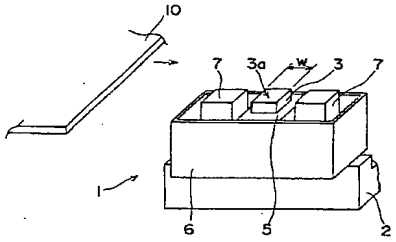
【図２】



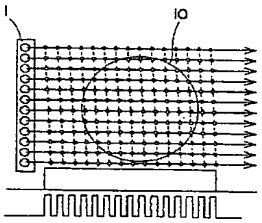
【図３】



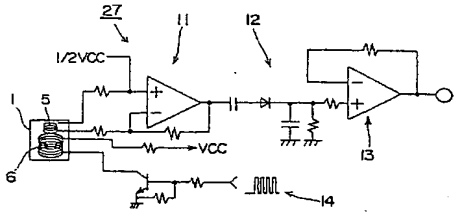
【図４】



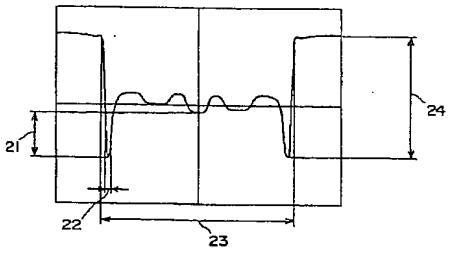
【図７】



【図５】



【図６】



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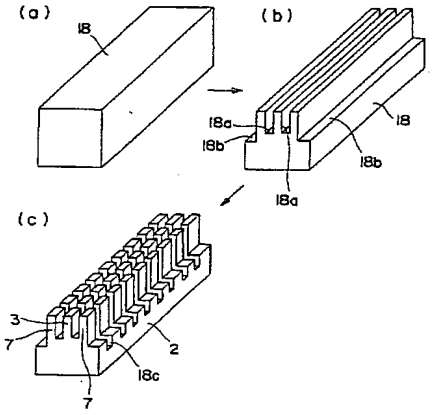
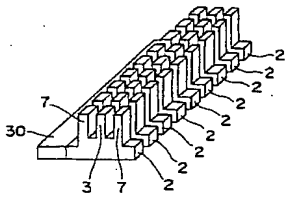
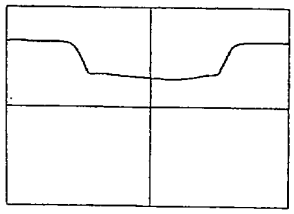
【図８】



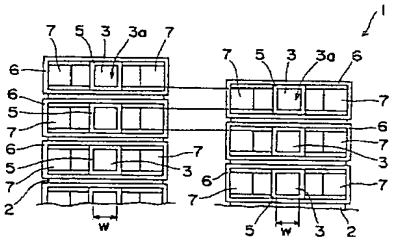
【図９】



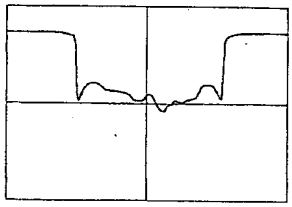
【図１２】



【図１０】

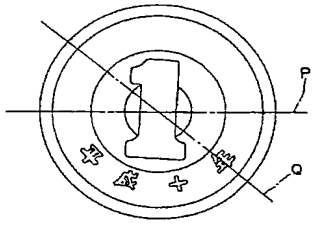


【図１１】

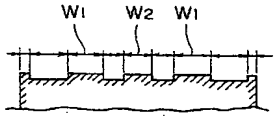


【図１３】

(A)



(B)



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